



US010411327B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.:** **US 10,411,327 B2**
(45) **Date of Patent:** **Sep. 10, 2019**

(54) **ANTENNA DEVICE AND ELECTRONIC
DEVICE INCLUDING SAME**

FOREIGN PATENT DOCUMENTS

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

CN 102469184 5/2012
CN 102751563 10/2012
(Continued)

(72) Inventors: **Ji-Won Kim**, Gyeonggi-do (KR); **Jinu Kim**, Seoul (KR); **Hui-Won Cho**,
Gyeonggi-do (KR)

OTHER PUBLICATIONS

European Search Report dated Oct. 20, 2016 issued in counterpart application No. 16157846.3-1811, 7 pages.
(Continued)

(73) Assignee: **Samsung Electronics Co., Ltd** (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 518 days.

Primary Examiner — Daniel Munoz

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(21) Appl. No.: **15/056,638**

(22) Filed: **Feb. 29, 2016**

(65) **Prior Publication Data**

US 2016/0254588 A1 Sep. 1, 2016

(30) **Foreign Application Priority Data**

Feb. 27, 2015 (KR) 10-2015-0028340

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

(52) **U.S. Cl.**

CPC **H01Q 1/24** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243
(Continued)

(56) **References Cited**

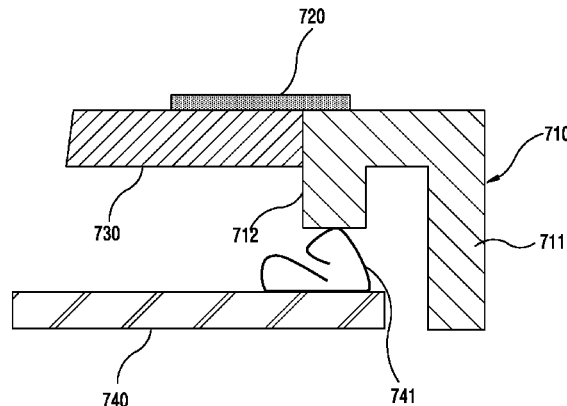
U.S. PATENT DOCUMENTS

8,188,930 B2 5/2012 Sung et al.
8,711,044 B2 4/2014 Arkko et al.
(Continued)

(57) **ABSTRACT**

An electronic device and an antenna device are provided herein. An electronic device includes a conductive sidewall; a conductive structure located within a space formed by the conductive sidewall and extending from the conductive sidewall, wherein the conductive structure includes a first surface directed toward a front of the portable electronic device and a second surface directed toward a back of the portable electronic device; a non-conductive structure located within the space formed by the conductive sidewall and contacting the conductive structure, wherein the non-conductive structure includes a first surface directed toward the front of the portable electronic device and a second surface directed toward the back of the portable electronic device; an antenna pattern electrically connected to the conductive structure; and a flexible conductive connector electrically connected to the conductive structure and the antenna pattern. The antenna pattern extends on a portion of the first surface of the conductive structure and on a portion of the first surface of the non-conductive structure, or extends on a portion of the second surface of the conductive structure and on a portion of the second surface of the non-conductive structure.

19 Claims, 39 Drawing Sheets





US010454154B2

(12) **United States Patent**
Yeom et al.

(10) **Patent No.:** **US 10,454,154 B2**

(45) **Date of Patent:** **Oct. 22, 2019**

(54) **ANTENNA DEVICE AND ELECTRONIC
DEVICE COMPRISING SAME**

(58) **Field of Classification Search**

CPC .. H01Q 1/24; H01Q 1/38; H01Q 9/42; H01Q
21/28

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(Continued)

(72) Inventors: **Jung-Hwan Yeom**, Gyeonggi-do (KR);
Bong-Soo Kang, Gyeonggi-do (KR);
Dae-Hun Jung, Gyeonggi-do (KR)

(56)

References Cited

U.S. PATENT DOCUMENTS

2008/0129644 A1 6/2008 Seo et al.
2010/0234066 A1 9/2010 Kobayashi et al.

(Continued)

(73) Assignee: **Samsung Electronics Co., Ltd** (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/775,545**

CN 103155281 6/2013
KR 1020070070549 7/2007

(Continued)

(22) PCT Filed: **Nov. 11, 2016**

(86) PCT No.: **PCT/KR2016/013021**

§ 371 (c)(1),

(2) Date: **May 11, 2018**

OTHER PUBLICATIONS

PCT/ISA/210 Search Report issued on PCT/KR2016/013021 (pp.
3).

(Continued)

(87) PCT Pub. No.: **WO2017/082686**

PCT Pub. Date: **May 18, 2017**

Primary Examiner — Andrea Lindgren Baltzell

(65) **Prior Publication Data**

US 2018/0351234 A1 Dec. 6, 2018

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm,
P.C.

(30) **Foreign Application Priority Data**

Nov. 11, 2015 (KR) 10-2015-0158407

(57)

ABSTRACT

An electronic device according to various embodiments is provided and includes a conductive inner module in which a plurality of layers are stacked; an electrical opening formed in at least a portion of the rim of the conductive inner module when stacking the plurality of layers; and an antenna module disposed at the periphery of the electrical opening, wherein the antenna module may include a feeding part formed on at least one of a plurality of layers forming the conductive inner module, and a conductive pattern which is connected to the feeding part and disposed circumferencing at least one of the electrical openings.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

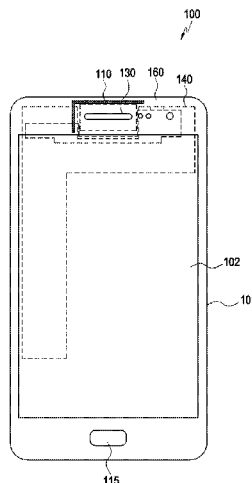
H01Q 9/42 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01Q 1/24** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 9/42**
(2013.01); **H01Q 21/28** (2013.01); **H04B 1/16**
(2013.01)

14 Claims, 17 Drawing Sheets



(12) **United States Patent**
Choon et al.

(10) **Patent No.:** **US 10,454,155 B2**
(45) **Date of Patent:** **Oct. 22, 2019**

(54) **ANTENNA MODULE AND MOBILE TERMINAL USING SAME**

(71) Applicants: **Tan Yew Choon**, Singapore (SG); **Ng Guan Hong**, Singapore (SG); **Tay Yew Siow**, Singapore (SG)

(72) Inventors: **Tan Yew Choon**, Singapore (SG); **Ng Guan Hong**, Singapore (SG); **Tay Yew Siow**, Singapore (SG)

(73) Assignee: **AAC Technologies Pte. Ltd.**, Singapore (SG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 54 days.

(21) Appl. No.: **15/283,539**

(22) Filed: **Oct. 3, 2016**

(65) **Prior Publication Data**

US 2017/0117615 A1 Apr. 27, 2017

(30) **Foreign Application Priority Data**

Oct. 26, 2015 (CN) 2015 1 0700339

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/328 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/328** (2015.01); **H01Q 9/0457** (2013.01); **H01Q 13/103** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0442; H01Q 9/42; H01Q 9/0457;

H01Q 13/103; H01Q 13/10; H01Q 13/106; H01Q 5/371; H01Q 7/005; H01Q 5/328; H01Q 9/0407; H01Q 9/26; H01Q 3/247; H01Q 1/243

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,614,282 B1 * 4/2017 Zheng H01Q 7/005
2004/0147297 A1 * 7/2004 Mikkola H01Q 1/243
455/575.7
2005/0219128 A1 * 10/2005 Tan H01Q 1/243
343/702
2008/0291111 A1 * 11/2008 Bae H01Q 1/243
343/860

(Continued)

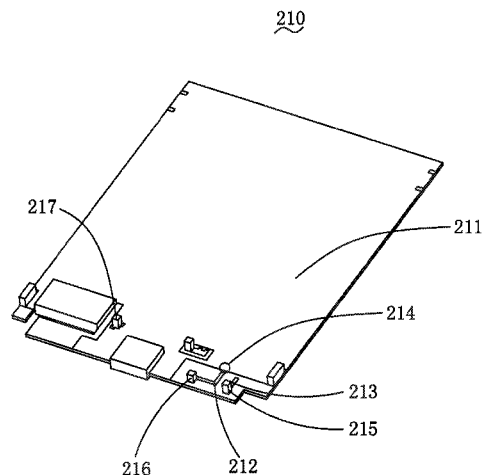
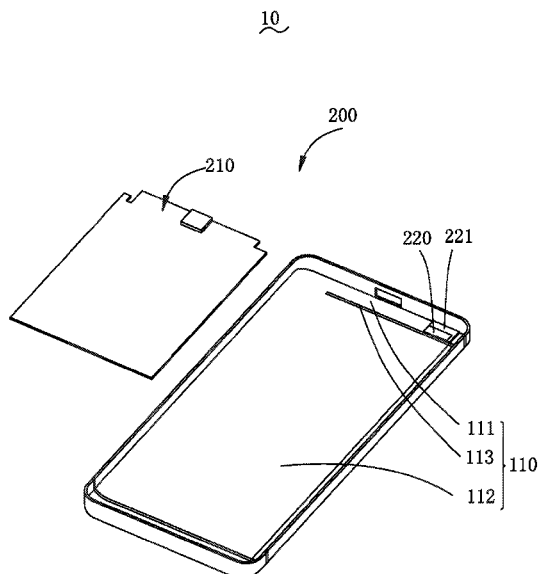
Primary Examiner — Ricardo I Magallanes

(74) *Attorney, Agent, or Firm* — IPro, PLLC; Na Xu

(57) **ABSTRACT**

An antenna module is disclosed. The antenna module includes a radiator. The radiator includes a first radiation part, a second radiation part connecting with the first radiation part partially and a coupling slot arranged between the first radiation part and the second radiation part. Further, the antenna module includes a circuit board which is arranged opposite to the radiator and includes a system base, a grounding line connecting with the system base electrically, a feeder line and a tuning switch controlling ON/OFF of the grounding line, and a capacitance feed sheet facing one side of the first radiation part which faces the circuit board and connecting with the first radiation part. The capacitance feed sheet is connected with the feeder line electrically; the grounding line is connected with the first radiation part electrically; and the system base is connected with the said second radiation part electrically.

10 Claims, 6 Drawing Sheets





US010454156B1

(12) **United States Patent**
Yang et al.

(10) **Patent No.:** **US 10,454,156 B1**
(45) **Date of Patent:** **Oct. 22, 2019**

(54) **ANTENNA STRUCTURE**

USPC 343/700 R
See application file for complete search history.

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(56) **References Cited**

(72) Inventors: **Cheng-Da Yang**, Hsinchu (TW);
Yan-Ting Wu, Hsinchu (TW); **Irving Tseng**, Hsinchu (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

10,218,077 B2 * 2/2019 Lepe H01Q 1/243
10,224,644 B1 * 3/2019 Park H01O 21/0075
10,290,946 B2 * 5/2019 Romano H01Q 13/10
10,355,339 B2 * 7/2019 Jin H01Q 21/28
2012/0231750 A1 9/2012 Jin et al.
2014/0292598 A1 10/2014 Bevelacqua et al.
2017/0033460 A1 2/2017 Ayala Vazquez et al.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **16/101,755**

TW 200835055 A 8/2008

(22) Filed: **Aug. 13, 2018**

* cited by examiner

(30) **Foreign Application Priority Data**

Primary Examiner — Brian K Young

Jun. 7, 2018 (TW) 107119672 A

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(51) **Int. Cl.**

(57) **ABSTRACT**

H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)
H01Q 13/10 (2006.01)
H01Q 5/378 (2015.01)
H01Q 9/04 (2006.01)
H01Q 9/16 (2006.01)
H01Q 1/48 (2006.01)
H04M 1/02 (2006.01)

An antenna structure includes a first ground element, a feeding element, a shorting element, a parasitic tuning element, a second ground element, a first parasitic element, a second parasitic element, and a dielectric substrate. The feeding element is coupled through the shorting element to the first ground element. The parasitic tuning element is coupled to the first ground element. The parasitic tuning element is at least partially surrounded by the feeding element, the shorting element, and the first ground element. The second ground element is adjacent to the feeding element. The first parasitic element and the second parasitic element are coupled to the second ground element. The feeding element, the shorting element, the parasitic tuning element, the first parasitic element, the second parasitic element, and at least one of the first ground element and the second ground element are disposed on the dielectric substrate.

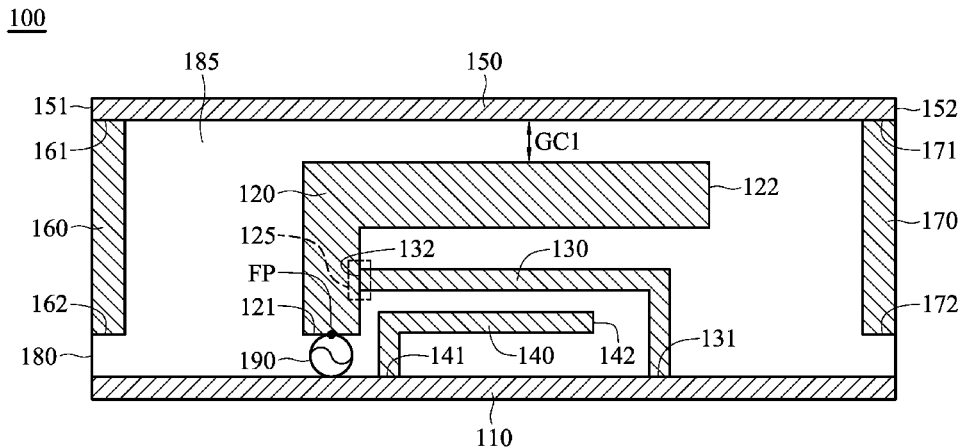
(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 9/16** (2013.01); **H01Q 13/10** (2013.01); **H04M 1/0202** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 9/16; H01Q 9/0421; H01Q 13/10; H01Q 5/33

20 Claims, 6 Drawing Sheets





US010454173B2

(12) **United States Patent**
Taachouche et al.

(10) **Patent No.:** **US 10,454,173 B2**
(45) **Date of Patent:** **Oct. 22, 2019**

(54) **FREQUENCY-TUNABLE AND SLOT-FED PLANAR ANTENNA, AND SATELLITE-BASED POSITIONING RECEIVER COMPRISING SUCH AN ANTENNA**

(71) Applicants: **Universite De Rennes 1**, Rennes (FR);
CNRS—Centre National de la Recherche Scientifique, Paris (FR)

(72) Inventors: **Yaakoub Taachouche**, Rennes (FR);
Mohamed Himdi, Rennes (FR)

(73) Assignees: **UNIVERSITE DE RENNES 1**,
Rennes (FR); **CNRS—CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 27 days.

(21) Appl. No.: **15/127,579**

(22) PCT Filed: **Mar. 17, 2015**

(86) PCT No.: **PCT/EP2015/055484**

§ 371 (c)(1),

(2) Date: **Sep. 20, 2016**

(87) PCT Pub. No.: **WO2015/140127**

PCT Pub. Date: **Sep. 24, 2015**

(65) **Prior Publication Data**

US 2017/0141471 A1 May 18, 2017

(30) **Foreign Application Priority Data**

Mar. 20, 2014 (FR) 14 52301

(51) **Int. Cl.**

H01Q 9/04 (2006.01)

H01Q 9/14 (2006.01)

H01Q 5/50 (2015.01)

H01Q 1/38 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01Q 9/0407** (2013.01); **H01Q 1/288**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48**
(2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 9/0407–0457
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,191,740 B1 2/2001 Kates et al.
2010/0073238 A1 3/2010 Jun et al.

FOREIGN PATENT DOCUMENTS

JP H01252002 A 10/1989
WO 2007006773 A1 1/2007

OTHER PUBLICATIONS

R. Caso, A. Serra, A. Buffi, M. Rodriguez-Pino, P. Nepa and G. Manara, "Dual-polarised slot-coupled patch antenna excited by a square ring slot," in IET Microwaves, Antennas & Propagation, vol. 5, No. 5, pp. 605-610, Apr. 2011.*

(Continued)

Primary Examiner — Jessica Han

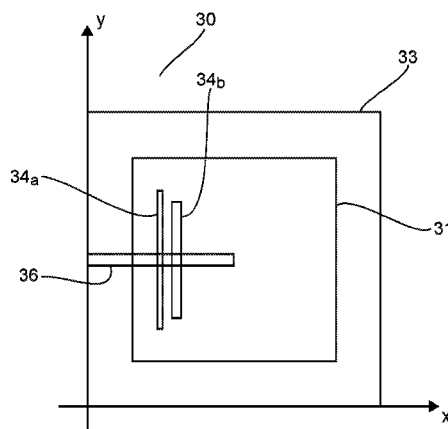
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — David D. Brush;
Westman, Champlin & Koehler, P.A.

(57) **ABSTRACT**

A Frequency-tunable and slot-fed planar antenna is proposed. The antenna includes resonant patch, a first dielectric layer, a ground plane having a first slot for each linear polarization, a second dielectric layer and a transmission line having, for each first slot, an end strand extending beneath the first slot. The antenna is frequency tunable for each linear polarization through at least one variable capacitance element. The matching of the antenna varies, for each linear polarization, as a function of a bias voltage applied to the

(Continued)





US010454176B2

(12) **United States Patent**
Koga et al.

(10) **Patent No.:** **US 10,454,176 B2**
(45) **Date of Patent:** **Oct. 22, 2019**

(54) **ANTENNA APPARATUS AND ELECTRONIC DEVICE**

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi, Kanagawa (JP)

(72) Inventors: **Yohei Koga**, Kawasaki (JP); **Takashi Yamagajo**, Yokosuka (JP); **Manabu Kai**, Yokohama (JP); **Mitsuharu Hoshino**, Kawasaki (JP); **Masatomo Mori**, Kawasaki (JP)

(73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/832,096**

(22) Filed: **Dec. 5, 2017**

(65) **Prior Publication Data**

US 2018/0183149 A1 Jun. 28, 2018

(30) **Foreign Application Priority Data**

Dec. 28, 2016 (JP) 2016-256728

(51) **Int. Cl.**

H01Q 9/40 (2006.01)
H01Q 9/38 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01Q 9/38** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 21/28** (2013.01); **H01Q 1/52** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 1/52; H01Q 9/40–9/42

USPC 343/700 MS, 702, 846–848
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,079,079 B2 * 7/2006 Jo H01Q 1/243
343/700 MS
7,289,068 B2 * 10/2007 Fujio H01Q 9/407
343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2007-281990 A 10/2007

Primary Examiner — Dameon E Levi

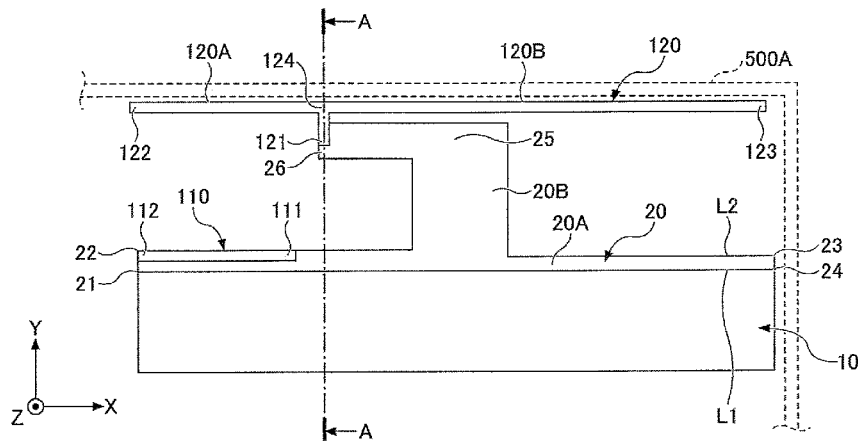
Assistant Examiner — Hasan Z Islam

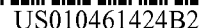
(74) *Attorney, Agent, or Firm* — Arent Fox LLP

(57) **ABSTRACT**

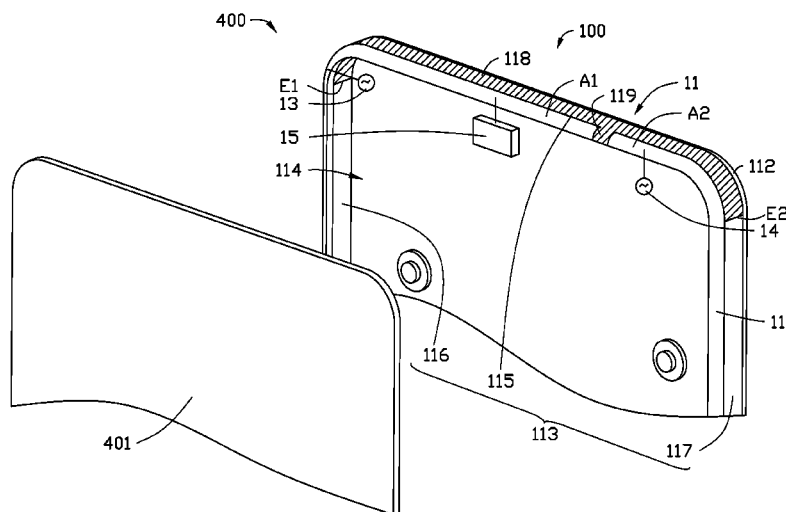
An antenna apparatus includes a ground plane having an edge; a monopole type first antenna element having a first feed point and configured to communicate at a first frequency; and a monopole type second antenna element having a second feed point and configured to communicate at a second frequency, the second antenna element extending from the second feed point in a direction away from the edge. An end portion of the first antenna element is arranged closer to the ground plane than an end portion of the second antenna element is. A length of an interval between the first feed point and the second feed point is in a range of from 0.25-fold to 0.7-fold of an electrical length of a first wavelength at the first frequency. A length of the second antenna element is a length in a range of from 0.15-fold to 0.55-fold of the electrical length.

5 Claims, 12 Drawing Sheets





(45) **Date of Patent:** *Oct. 29, 2019





US010461425B2

(12) **United States Patent**
Liou

(10) **Patent No.:** **US 10,461,425 B2**
(45) **Date of Patent:** **Oct. 29, 2019**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(2013.01); **H01Q 9/42** (2013.01); **H01Q 13/106** (2013.01); **H01Q 21/28** (2013.01); **H01Q 1/36** (2013.01)

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(58) **Field of Classification Search**
CPC H01Q 13/18; H01Q 9/0407; H01Q 1/286; H01Q 1/243; H01Q 1/38; H01Q 9/0421
USPC 343/746, 702, 872, 878
See application file for complete search history.

(72) Inventor: **Geng-Hong Liou**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

U.S. PATENT DOCUMENTS

2011/0275333 A1 11/2011 Kim et al.
2013/0257659 A1* 10/2013 Darnell H01Q 1/243 343/702

(21) Appl. No.: **15/786,756**

(Continued)

(22) Filed: **Oct. 18, 2017**

FOREIGN PATENT DOCUMENTS

(65) **Prior Publication Data**

US 2018/0131092 A1 May 10, 2018

CN 103390793 A 11/2013
CN 105390801 A 3/2016
CN 105958201 A 9/2016

Primary Examiner — Hai V Tran

Assistant Examiner — Collin Dawkins

(30) **Foreign Application Priority Data**

Nov. 4, 2016 (CN) 2016 1 0977565

(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a metallic member, a feed portion, a ground portion, and a radiator. The metallic member defines at least one slot and is divided into a first combining portion and a second combining portion by the at least one slot. The feed portion feeds current to the first combining portion. The ground portion grounds the first combining portion. The radiator feeds current to the second combining portion. The first combining portion, the feed portion, and the ground portion cooperatively form a first antenna to activate a first mode for generating radiation signals in a first frequency band. The second combining portion and the radiator cooperatively form a second antenna to activate a second mode for generating radiation signals in a second frequency band.

(51) **Int. Cl.**

H01Q 13/10 (2006.01)

H01Q 5/50 (2015.01)

H01Q 5/371 (2015.01)

H01Q 5/378 (2015.01)

H01Q 9/30 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 21/28 (2006.01)

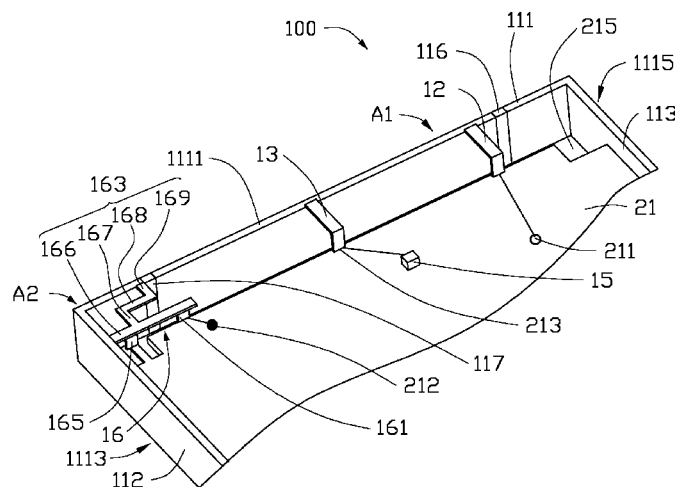
H01Q 5/35 (2015.01)

H01Q 1/36 (2006.01)

(52) **U.S. Cl.**

CPC **H01Q 5/50** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/30**

19 Claims, 12 Drawing Sheets





US010461427B2

(12) **United States Patent**
Hwang et al.

(10) **Patent No.:** **US 10,461,427 B2**
(45) **Date of Patent:** **Oct. 29, 2019**

(54) **ANTENNA AND ELECTRONIC DEVICES
COMPRISING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si, Gyeonggi-do (KR)

(72) Inventors: **Soon Ho Hwang**, Seoul (KR); **Sung
Koo Park**, Suwon-si (KR); **Joon Ho
Byun**, Yongin-si (KR); **Chan Kyu An**,
Incheon (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 125 days.

8,988,290 B2	3/2015	Ozden et al.
9,343,804 B2	5/2016	Oh et al.
2002/0190905 A1	12/2002	Flint et al.
2004/0154766 A1	8/2004	Rancien et al.
2006/0208951 A1	9/2006	Korva et al.
2008/0202715 A1	8/2008	Rancien et al.
2009/0315789 A1	12/2009	Sung et al.
2010/0123633 A1	5/2010	Ozden et al.
2012/0112969 A1	5/2012	Caballero et al.
2012/0212378 A1	8/2012	Sung et al.
2012/0262345 A1	10/2012	Kim et al.
2013/0027254 A1	1/2013	Korva et al.
2013/0027270 A1	1/2013	Von Arbin et al.
2013/0057437 A1	3/2013	Chiu et al.
2013/0099980 A1*	4/2013	Hayashi H01Q 9/42 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/681,521**

EP	2 500 979 A2	9/2012
EP	2511979 A1	10/2012

(22) Filed: **Apr. 8, 2015**

(Continued)

(65) **Prior Publication Data**

US 2016/0301138 A1 Oct. 13, 2016

OTHER PUBLICATIONS

European Office Action dated Feb. 7, 2019, Application #: 15 162
919.3-1206; Ref. # P6055735EP.

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)

Primary Examiner — Jessica Han

Assistant Examiner — Michael Bouizza

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 9/42** (2013.01)

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 9/42; H01Q 1/243
See application file for complete search history.

(57) **ABSTRACT**

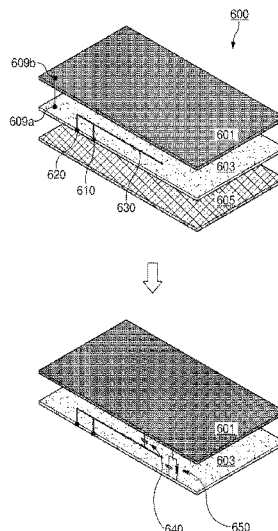
An electronic device having an antenna is provided. The electronic device includes a substrate including a grounding area, a non-grounding area and at least one feeding unit for feeding an antenna radiator, and a non-segmented metal cover forming an outer frame of the electronic device and operating as a part of the antenna.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,872,706 B2	10/2014	Caballero et al.
8,878,732 B1	11/2014	Sung et al.

8 Claims, 12 Drawing Sheets





US010461794B2

(12) **United States Patent**
Youn et al.

(10) **Patent No.:** **US 10,461,794 B2**

(45) **Date of Patent:** **Oct. 29, 2019**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul
(KR)

(72) Inventors: **Yeomin Youn**, Seoul (KR); **Jaehyun Choi**, Seoul (KR); **Jungsun Ahn**, Seoul (KR); **Changil Kim**, Seoul (KR); **Kangjae Jung**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul
(KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/122,600**

(22) Filed: **Sep. 5, 2018**

(65) **Prior Publication Data**

US 2019/0007085 A1 Jan. 3, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/961,227, filed on Apr. 24, 2018, now Pat. No. 10,122,401, which is a
(Continued)

(30) **Foreign Application Priority Data**

Dec. 3, 2013 (KR) 10-2013-0149413

(51) **Int. Cl.**

H04B 1/3888 (2015.01)

H01Q 1/24 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H04B 1/3888** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1656** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H04B 1/3888; H04B 2001/3894; H04M 1/0202; H04M 1/0249; H04M 1/18
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,097,934 A * 8/2000 Spall H01Q 11/08
455/575.7

7,053,848 B2 5/2006 Shoji et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 02262724 10/1990
KR 1020070112391 11/2007

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 15/783,873, Notice of Allowance dated Jan. 24, 2018, 23 pages.

(Continued)

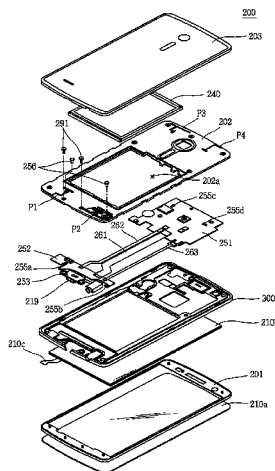
Primary Examiner — April G Gonzales

(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(57) **ABSTRACT**

A mobile terminal includes a metal frame including a base portion and an edge portion formed along the outer edge of the base portion, first and second cases bonded to the front and back sides of the metal frame so as to expose the edge portion to the outside, first and second waterproof layers formed between the cases and the metal frame, conductive members that operate a radiator for antennas, together with the edge portion, and are formed on one side of the second case, and feeding portions for feeding the conductive members, the feeding portions being disposed in an enclosed space formed by the waterproof layers.

14 Claims, 15 Drawing Sheets





US010468746B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.:** **US 10,468,746 B2**
(45) **Date of Patent:** **Nov. 5, 2019**

(54) **ELECTRONIC DEVICE HAVING LOOP ANTENNA**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si, Gyeonggi-do (KR)

9,727,765 B2 * 8/2017 Ikemoto G06K 7/10346
10,031,559 B1 * 7/2018 Hamel G06F 1/1679
(Continued)

(72) Inventors: **Woosup Lee**, Suwon-si (KR); **Jungsik Park**, Suwon-si (KR)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si, Gyeonggi-do (KR)

EP 2 573 871 3/2013
EP 2 894 716 7/2015
(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 211 days.

OTHER PUBLICATIONS

Extended Search Report dated Feb. 12, 2018 in counterpart European Patent Application No. 17194796.3.

(21) Appl. No.: **15/718,327**

Primary Examiner — Hoang V Nguyen

(22) Filed: **Sep. 28, 2017**

Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(65) **Prior Publication Data**

US 2018/0097275 A1 Apr. 5, 2018

(30) **Foreign Application Priority Data**

Oct. 5, 2006 (KR) 10-2016-0128402

(51) **Int. Cl.**

H01Q 1/22 (2006.01)

H01Q 7/00 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01Q 1/2266** (2013.01); **G06F 1/1635** (2013.01); **G06F 1/1637** (2013.01);

(Continued)

(58) **Field of Classification Search**

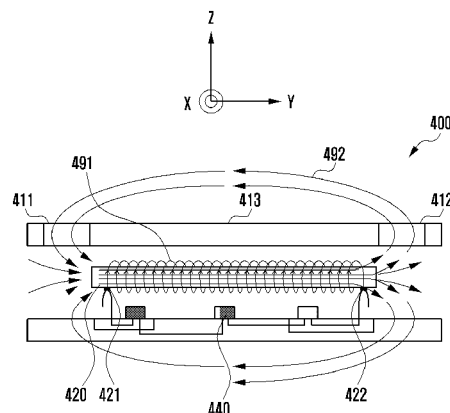
CPC ... G06F 1/1635; G06F 1/1637; H04B 5/0087; H01Q 7/00; H01Q 1/2266; G06K 19/07779

See application file for complete search history.

(57) **ABSTRACT**

An electronic device includes a housing including a first surface facing in a first direction, a second surface facing in a second direction to the first direction, and a side member enclosing at least a portion of a space between the first surface and the second surface; a first metal plate positioned between the first surface and the second surface; a conductive coil positioned within the housing, having a shaft substantially perpendicular to the first direction or the second direction, and that winds around the first metal plate; a first communication circuit positioned within the housing and electrically connected to the conductive coil; a second communication circuit positioned within the housing and electrically connected to the first metal plate; a display exposed through at least a portion of the first surface; and a processor positioned within the housing and electrically connected to the first communication circuit, the second communication circuit, and the display. The second surface may include a first portion made of a conductive material and including a first opening and a second portion made of a non-conductive material and that fills the first opening. The

(Continued)





US010468749B2

(12) **United States Patent**
Lu et al.

(10) **Patent No.:** **US 10,468,749 B2**
(45) **Date of Patent:** **Nov. 5, 2019**

(54) **MOBILE DISPLAY TERMINAL**

(71) Applicant: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Yongchun Lu**, Beijing (CN); **Jian Xu**, Beijing (CN); **Xinyin Wu**, Beijing (CN); **Yong Qiao**, Beijing (CN); **Jianbo Xian**, Beijing (CN)

(73) Assignee: **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 5 days.

(21) Appl. No.: **14/915,613**

(22) PCT Filed: **Sep. 29, 2015**

(86) PCT No.: **PCT/CN2015/091078**

§ 371 (c)(1),

(2) Date: **Feb. 29, 2016**

(87) PCT Pub. No.: **WO2016/155275**

PCT Pub. Date: **Oct. 6, 2016**

(65) **Prior Publication Data**

US 2017/0040669 A1 Feb. 9, 2017

(30) **Foreign Application Priority Data**

Apr. 3, 2015 (CN) 2015 2 0200997 U

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

H01Q 21/28 (2006.01)

(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/38; H01Q 1/50; H01Q 21/28

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,217,898 B2 * 5/2007 Chien H01H 23/14 200/339

2006/0170597 A1 * 8/2006 Kurashima H01Q 1/22 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101500381 A 8/2009

CN 201467180 U 5/2010

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion in PCT International Application No. PCT/CN2015/091078, dated Jan. 6, 2016.

Primary Examiner — Robert Karacsony

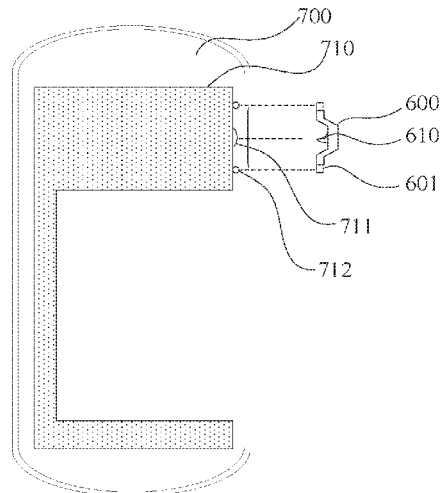
(74) *Attorney, Agent, or Firm* — Brooks Kushman P.C.

(57)

ABSTRACT

The present disclosure provides a mobile display terminal, including a case, a main board and an antenna. The main board is arranged inside the case, a circuit board is arranged on the main board, and the antenna is arranged on the case. The mobile display terminal further includes a connector configured to electrically connect the antenna to the circuit board.

9 Claims, 6 Drawing Sheets



(12) **United States Patent
Park**

(10) **Patent No.: US 10,468,750 B2**
(45) **Date of Patent: Nov. 5, 2019**

(54) **ANTENNA AND ELECTRONIC DEVICE
INCLUDING THE SAME**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

6,429,818 B1 * 8/2002 Johnson H01Q 1/243
343/700 MS

(72) Inventor: **Joo-Hwan Park**, Gyeonggi-do (KR)

2001/0050647 A1 * 12/2001 Kanayama H01Q 1/243
343/702

(73) Assignee: **Samsung Electronics Co., Ltd** (KR)

2003/0091183 A1 * 5/2003 Holcombe H04B 14/026
379/399.01

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 93 days.

2007/0018749 A1 * 1/2007 Yamaguchi H01P 5/00
333/5

2011/0032165 A1 2/2011 Heng et al.
(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/946,267**

CN 202352836 7/2012
CN 102859791 1/2013

(22) Filed: **Nov. 19, 2015**

(Continued)

(65) **Prior Publication Data**

US 2016/0149291 A1 May 26, 2016

OTHER PUBLICATIONS

(30) **Foreign Application Priority Data**

Nov. 21, 2014 (KR) 10-2014-0163756

European Search Report dated Mar. 8, 2016 issued in counterpart
application No. 15195550.7-1811, 9 pages.

European Search Report dated Mar. 9, 2017 issued in counterpart
application No. 15195550.7-1927, 8 pages.

European Search Report dated Nov. 20, 2017 issued in counterpart
application No. 15195550.7-1927, 8 pages.

(Continued)

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 5/328 (2015.01)

H01Q 5/378 (2015.01)

H01Q 1/48 (2006.01)

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Awat M Salih

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm,
P.C.

(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 5/328** (2015.01); **H01Q**
5/378 (2015.01)

(57) **ABSTRACT**

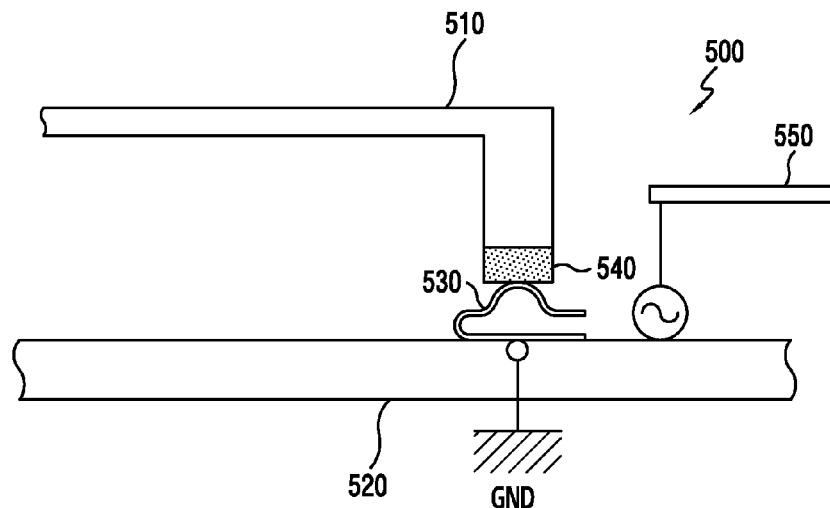
Provided are an antenna and an electronic device including
the same. The antenna includes a substrate, an antenna
radiator fed from the substrate, at least one metallic member
disposed near the antenna radiator, a connector member
electrically connected to the substrate, and a capacitor
formed by a dielectric interposed between the connector
member and the at least one metallic member.

(58) **Field of Classification Search**

CPC .. H01Q 1/241–244; H01Q 1/48; H01Q 5/328;
H01Q 5/371; H01Q 5/378; H01Q 5/385;
H01Q 19/005; H01Q 19/32; H01Q 3/446;
H01Q 1/243

See application file for complete search history.

13 Claims, 17 Drawing Sheets





US010468754B2

(12) **United States Patent**
Vanjani

(10) **Patent No.:** **US 10,468,754 B2**

(45) **Date of Patent:** **Nov. 5, 2019**

(54) **BIFURCATED MULTI-MODE RING
ANTENNA FOR A WIRELESS
COMMUNICATION DEVICE**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Futurewei Technologies, Inc.**, Plano,
TX (US)

(72) Inventor: **Kiran Vanjani**, San Diego, CA (US)

(73) Assignee: **FUTUREWEI TECHNOLOGIES,
INC.**, Plano, TX (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1 day.

7,183,983 B2 *	2/2007	Ozden		H01Q 1/243	343/700 MS
7,233,291 B2 *	6/2007	Elkobi		H01Q 1/243	343/700 MS
7,450,072 B2 *	11/2008	Kim		H01Q 1/243	343/700 MS
8,279,611 B2 *	10/2012	Wong		H01P 3/121	361/749
8,786,507 B2 *	7/2014	Ayatollahi		H01Q 1/38	343/725
9,462,096 B2 *	10/2016	Han		H01Q 1/243	
2014/0139379 A1	5/2014	Bolin et al.			
2016/0191681 A1 *	6/2016	Han		H01Q 1/243	455/575.7

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/835,150**

(22) Filed: **Dec. 7, 2017**

CN	103825086 A	5/2014
CN	104269606 A	1/2015
CN	105609969 A	5/2016
EP	2337150 A1	6/2011

(65) **Prior Publication Data**

US 2019/0181537 A1 Jun. 13, 2019

OTHER PUBLICATIONS

International Search Report dated Jan. 22, 2019, in PCT Application
No. PCT/CN2018/116678, 9 pages.

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/30 (2015.01)
H01Q 13/10 (2006.01)

* cited by examiner

Primary Examiner — Jean B Jeanglaude
(74) *Attorney, Agent, or Firm* — Vierra Magen Marcus
LLP

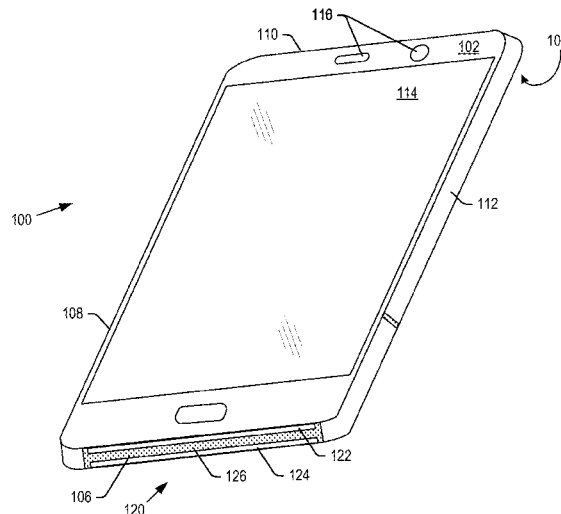
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/30**
(2015.01); **H01Q 7/00** (2013.01); **H01Q 13/10**
(2013.01)

(57) **ABSTRACT**

The present technology relates to a multiband antenna for
wireless mobile communication devices such as cellular
telephones. The antenna may include a bifurcated ring
structure along one, two, three or all four edges of the
device. The ring structure may include bifurcated metal
conductors, or bars, extending along the length of the one or
more edges.

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 7/00; H01Q 5/30;
H01Q 13/10
USPC 343/700 MS, 725
See application file for complete search history.

35 Claims, 7 Drawing Sheets





US010468757B2

(12) **United States Patent**
Wang et al.

(10) **Patent No.:** **US 10,468,757 B2**
(45) **Date of Patent:** **Nov. 5, 2019**

(54) **WEARABLE DEVICE AND ANTENNA THEREOF**

(71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)

(72) Inventors: **Wen Wang**, Shenzhen (CN); **Shuhui Sun**, Shenzhen (CN); **Qing Liu**,
Shenzhen (CN); **Lina Chen**, Shenzhen
(CN)

(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/779,407**

(22) PCT Filed: **Nov. 27, 2015**

(86) PCT No.: **PCT/CN2015/095745**

§ 371 (c)(1),

(2) Date: **May 25, 2018**

(87) PCT Pub. No.: **WO2017/088164**

PCT Pub. Date: **Jun. 1, 2017**

(65) **Prior Publication Data**

US 2018/0309194 A1 Oct. 25, 2018

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/27 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/273** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 9/0414** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/50; H01Q 13/10;
H01Q 1/385

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,768,217 A * 6/1998 Sonoda G04B 47/025
368/10

8,773,847 B2 * 7/2014 Byun H04B 1/385
361/679.03

(Continued)

FOREIGN PATENT DOCUMENTS

CN 104466363 A 3/2015
CN 104617376 A 5/2015

(Continued)

OTHER PUBLICATIONS

Machine Translation and Abstract of Japanese Publication No.
JPH09247006, Sep. 19, 1997, 7 pages.

(Continued)

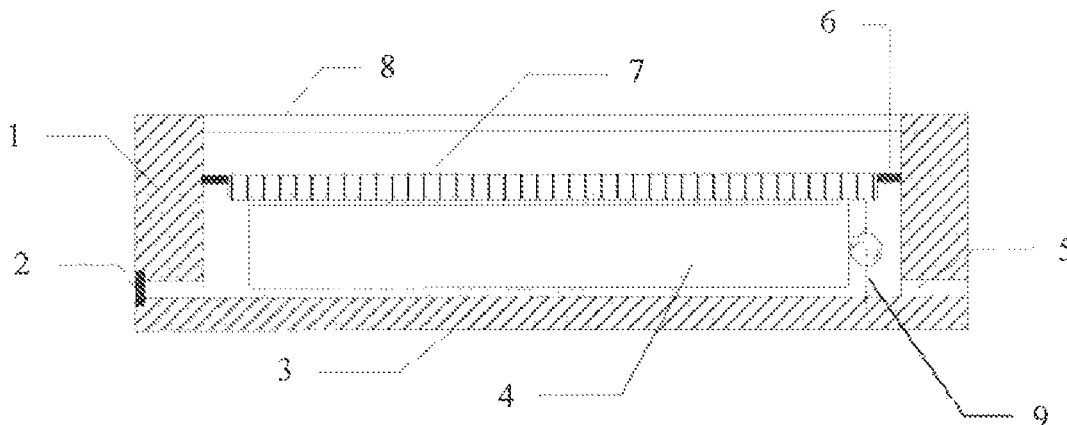
Primary Examiner — Huedung X Mancuso

(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna of a wearable device includes a metal bottom housing of the wearable device, a printed circuit board, a metal middle housing that encircles the printed circuit board, and a communications circuit set on the printed circuit board. A slot exists between the metal middle housing and the metal bottom housing. The metal middle housing is connected to the metal bottom housing using a second connecting wire. The metal middle housing and the printed circuit board jointly serve as a ground plate. An antenna feed line is used to connect the metal bottom housing and the communications circuit module. The metal bottom housing serves as an antenna radiation body.

11 Claims, 1 Drawing Sheet





US010468775B2

(12) **United States Patent**
Xiang et al.

(10) **Patent No.:** **US 10,468,775 B2**
(45) **Date of Patent:** **Nov. 5, 2019**

(54) **ANTENNA ASSEMBLY, WIRELESS COMMUNICATIONS ELECTRONIC DEVICE AND REMOTE CONTROL HAVING THE SAME**

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/085; H01Q 13/106; H01Q 13/08; H01Q 9/0407; H01Q 21/08
(Continued)

(71) Applicant: **AUTEL ROBOTICS CO., LTD.**,
Shenzhen, Guangdong (CN)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Shengzhao Xiang**, Guangdong (CN);
Yiye Sun, Guangdong (CN);
Zhuanpeng Cheng, Guangdong (CN)

6,181,281 B1 * 1/2001 Desclos H01Q 1/38
343/700 MS
6,515,629 B1 * 2/2003 Kuo H01Q 1/38
343/700 MS

(73) Assignee: **AUTEL ROBOTICS CO., LTD.**,
Shenzhen, Guangdong (CN)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

CN 101159351 A 4/2008
CN 201298596 Y 8/2009
(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/883,673**

OTHER PUBLICATIONS

(22) Filed: **Jan. 30, 2018**

International Search Report dated Feb. 13, 2018; PCT/CN2017/107379 ***English Translation Is Not Yet Available From WIPO***.

(65) **Prior Publication Data**

US 2018/0331430 A1 Nov. 15, 2018

(Continued)

Primary Examiner — Lam T Mai

Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2017/107379, filed on Oct. 23, 2017.

Foreign Application Priority Data

May 12, 2017 (CN) 2017 1 0335550

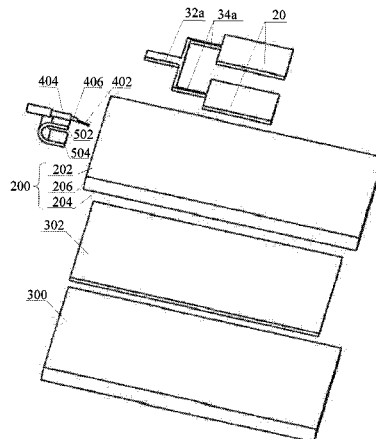
(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/0407** (2013.01);
(Continued)

(57) **ABSTRACT**

The present application relates to the field of communications, and provides an antenna assembly which is disposed in a wireless communications electronic device. The wireless communications electronic device is provided with a substrate. The antenna assembly includes: a radiation element, disposed at a first surface of the radiation element; a feeder, electrically connected to the radiation element; and a reference ground, disposed at a second surface of the substrate. The antenna assembly in the embodiments of the present application uses the substrate of the wireless communications electronic device as a medium to bear the radiation element, reducing space and costs of the antenna assembly; and because the substrate is relatively thick, a bandwidth of the antenna assembly is also increased. The

(Continued)





US010476131B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.:** **US 10,476,131 B2**

(45) **Date of Patent:** **Nov. 12, 2019**

(54) **ELECTRONIC DEVICE HAVING ANTENNA**

USPC 343/702

See application file for complete search history.

(71) Applicant: **HONGBO WIRELESS
COMMUNICATION
TECHNOLOGY CO., LTD.**, Taipei
(TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Yao-Yuan Chang**, Taipei (TW);
Chih-Chia Huang, Taipei (TW);
Tsung-Wen Chiu, Taipei (TW)

7,068,229 B2	6/2006	Lin	
8,264,412 B2 *	9/2012	Ayala	H01Q 9/42 343/700 MS
9,036,339 B2	5/2015	Schlesener et al.	
9,203,137 B1 *	12/2015	Guterman	H01Q 1/2266
2001/0040529 A1	11/2001	Cheng et al.	
2008/0238787 A1 *	10/2008	Lin	G06F 1/1616 343/702
2010/0073243 A1	3/2010	Ayala Vazquez et al.	
2010/0149751 A1 *	6/2010	Camacho	G06F 1/1616 361/679.55
2010/0321255 A1 *	12/2010	Kough	H01Q 1/2266 343/702

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 454 days.

(21) Appl. No.: **15/334,073**

(22) Filed: **Oct. 25, 2016**

(65) **Prior Publication Data**

US 2018/0026331 A1 Jan. 25, 2018

(30) **Foreign Application Priority Data**

Jul. 22, 2016 (TW) 105123412 A

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/50	(2006.01)
H01Q 9/06	(2006.01)
H01Q 1/48	(2006.01)

(52) **U.S. Cl.**

CPC **H01Q 1/2266** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01); **H01Q 9/065** (2013.01); **H01Q 13/10** (2013.01); **H01Q 13/106** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/50; H01Q 1/2266; H01Q 13/106;
H01Q 1/48; H01Q 9/065; H01Q 1/22;
H01Q 13/10

(Continued)

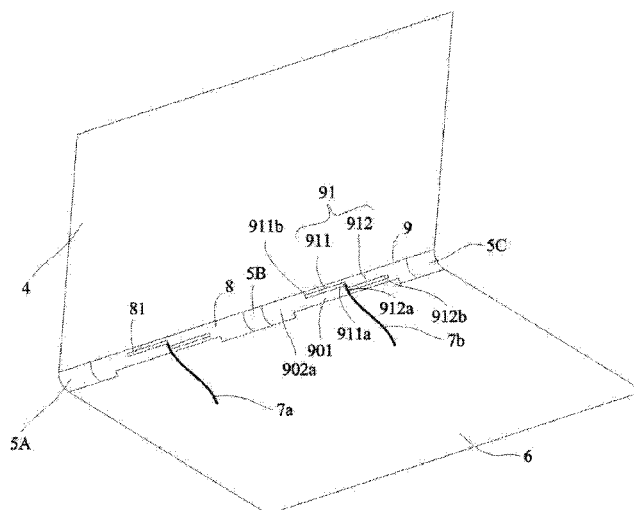
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Opes IP Consulting Co., Ltd.

(57) **ABSTRACT**

An electronic device having an antenna comprises a first metal casing, a second metal casing, a first hinge, a second hinge, and a first dipole antenna. A first slot antenna structure having a first half-wavelength resonant mode is constituted by the first hinge, the first metal casing, the second hinge and the second metal casing. The width of a first middle portion of the first slot antenna structure is narrower than the widths of the two end portions. The first dipole antenna unit located in the middle portion of the first slot antenna structure has a second half-wavelength resonant mode. The first dipole antenna is for exciting the first half-wavelength resonant mode. Accordingly, the antenna can be integrated with the hinges of the electronic device.

9 Claims, 5 Drawing Sheets





(12) **United States Patent**
Su

(10) **Patent No.:** **US 10,476,137 B1**
(45) **Date of Patent:** **Nov. 12, 2019**

(54) **TERMINAL HOUSING AND TERMINAL**

(56) **References Cited**

(71) Applicant: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

U.S. PATENT DOCUMENTS

(72) Inventor: **Jinhuai Su**, Beijing (CN)

(73) Assignee: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

10,271,299 B1 * 4/2019 Sayem H04W 64/00
2002/0033773 A1 * 3/2002 Hirabayashi G06F 1/1632
343/702
2004/0075613 A1 * 4/2004 Jarmuszewski H01Q 1/243
343/702
2006/0227058 A1 * 10/2006 Zellweger H01Q 1/273
343/718
2006/0238423 A1 * 10/2006 Ozden H01Q 1/243
343/702
2016/0064804 A1 * 3/2016 Kim H01Q 1/243
343/702
2017/0373388 A1 * 12/2017 Wang H01Q 1/44

* cited by examiner

(21) Appl. No.: **16/384,924**

(22) Filed: **Apr. 16, 2019**

Primary Examiner — Dinh Nguyen

(30) **Foreign Application Priority Data**

(74) *Attorney, Agent, or Firm* — Arch & Lake LLP

May 28, 2018 (CN) 2018 1 0525028

(57) **ABSTRACT**

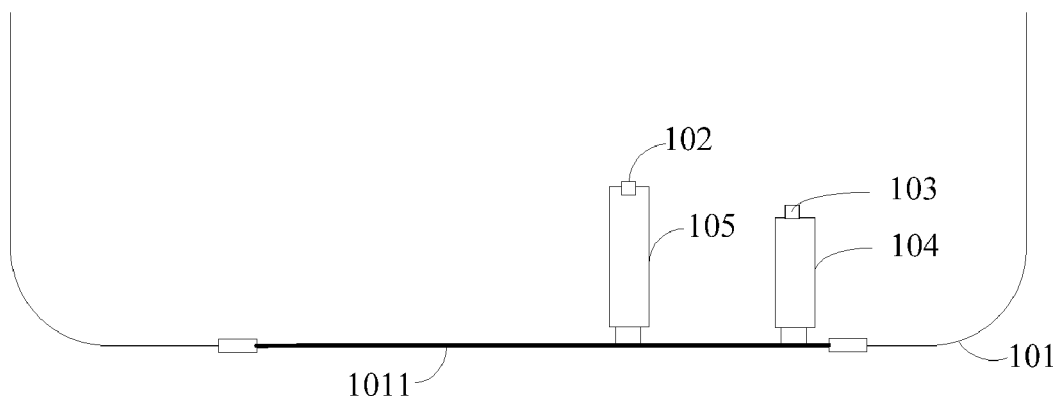
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H04M 1/02 (2006.01)

The present disclosure provides a terminal housing and a terminal. The main board unit in the terminal housing includes a power supply module, a switching module, a first grounding area, a second grounding area and a third grounding area; the antenna unit includes a horizontal bezel, a first branch, a second branch, a third branch and a fourth branch; the power supply module is connected to the horizontal bezel through the first branch; the first end of the switching module is connected to the contact area of the second branch, the third branch, and the fourth branch, the second end of the switching module is connected to the third grounding area, and the switching module is configured to control the first end to be connected to or disconnected from the second end.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H04M 1/0249** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243; H01Q 1/38; H01Q 1/48; H01Q 1/50; H01Q 1/52; H01Q 1/521; H01Q 1/523; H04M 1/0249
See application file for complete search history.

20 Claims, 4 Drawing Sheets





US010476151B2

(12) **United States Patent**
Seo et al.

(10) **Patent No.:** **US 10,476,151 B2**
(45) **Date of Patent:** **Nov. 12, 2019**

(54) **ANTENNA APPARATUS AND ELECTRONIC DEVICE HAVING THE SAME**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si, Gyeonggi-do (KR)
(72) Inventors: **Jaemin Seo**, Suwon-si (KR); **Suyang Park**, Hwaseong-si (KR); **Jaesun Park**,
Suwon-si (KR)
(73) Assignee: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)

2008/0204340	A1	8/2008	Kim et al.	
2010/0238072	A1	9/2010	Ayatollahi et al.	
2011/0057852	A1 *	3/2011	Holland	H01Q 9/28 343/795
2012/0032865	A1 *	2/2012	Toyao	H01P 1/2005 343/835
2012/0319919	A1 *	12/2012	Kirovski	H01Q 1/243 343/853
2013/0120201	A1	5/2013	Park et al.	

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1007 days.

FOREIGN PATENT DOCUMENTS

CN	102884680	A	1/2013
JP	2012-39465	A	2/2012
JP	2012-109809	A	6/2012

(Continued)

(21) Appl. No.: **14/282,551**

(22) Filed: **May 20, 2014**

OTHER PUBLICATIONS

(65) **Prior Publication Data**
US 2014/0347242 A1 Nov. 27, 2014

Korean Office Action dated Jan. 28, 2019, issued in Korean Patent Application No. 10-2013-0059565.

Primary Examiner — Dameon E Levi

Assistant Examiner — Collin Dawkins

(30) **Foreign Application Priority Data**

May 27, 2013 (KR) 10-2013-0059565

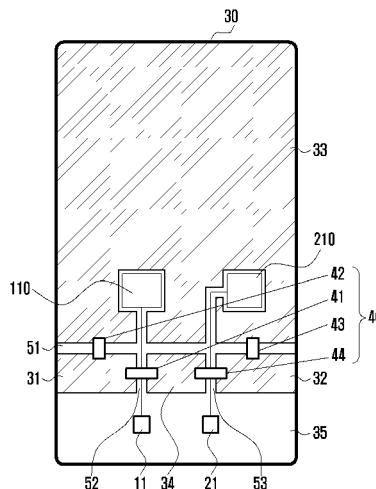
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An antenna apparatus that is able to improve isolation between antennas that are arranged adjacent to each other and an electronic device having the same are provided. The antenna apparatus includes a plurality of antennas, and a printed circuit board connected to the plurality of antennas, wherein the printed circuit board comprises a plurality of feeding units respectively connected to the plurality of antennas and a plurality of ground units respectively connected to the plurality of antennas, and each of the ground units is separated from the other ground units by means of at least one slot.

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01)
(58) **Field of Classification Search**
CPC .. H01Q 1/48; H01Q 9/40; H01Q 1/12; H01Q 1/243
USPC 343/848, 702, 878
See application file for complete search history.

21 Claims, 6 Drawing Sheets





US010476161B2

(12) **United States Patent**
Yamagajo et al.

(10) **Patent No.:** **US 10,476,161 B2**

(45) **Date of Patent:** **Nov. 12, 2019**

(54) **LOOP ANTENNA AND ELECTRONIC APPARATUS**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi,
Kanagawa (JP)

5,606,259 A	2/1997	Potthast et al.	
6,927,737 B2 *	8/2005	Inoue	H01Q 1/38 343/727
7,342,498 B2 *	3/2008	Baba	G06K 19/07749 340/572.5

(72) Inventors: **Takashi Yamagajo**, Yokosuka (JP);
Manabu Kai, Yokohama (JP)

2005/0151690 A1	7/2005	Minemura	
2011/0121080 A1	5/2011	Kai et al.	
2016/0204518 A1 *	7/2016	Yamagajo	H01Q 21/24 343/809

(73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

FOREIGN PATENT DOCUMENTS

JP	07-289535	11/1995
JP	2005-203854	7/2005
JP	2008-092259	4/2008
JP	2011-109552	6/2011

* cited by examiner

Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Fujitsu Patent Center

(21) Appl. No.: **15/993,676**

(22) Filed: **May 31, 2018**

(65) **Prior Publication Data**

US 2018/0366827 A1 Dec. 20, 2018

(30) **Foreign Application Priority Data**

Jun. 15, 2017 (JP) 2017-117720

(51) **Int. Cl.**

H01Q 7/00 (2006.01)

H01Q 1/38 (2006.01)

(52) **U.S. Cl.**

CPC **H01Q 7/00** (2013.01); **H01Q 1/38**
(2013.01)

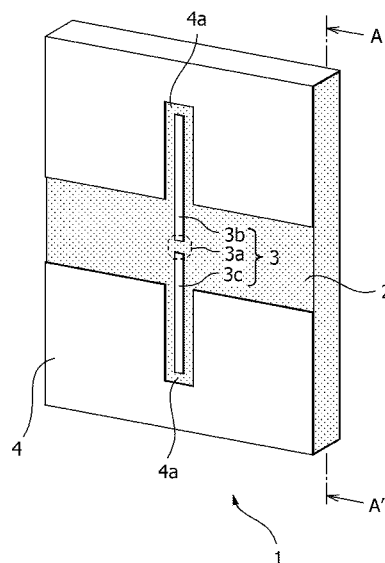
(58) **Field of Classification Search**

CPC H01Q 7/00; H01Q 1/38
See application file for complete search history.

(57) **ABSTRACT**

A loop antenna includes: a substrate; a feeding element including a first portion and a second portion which are provided on a first surface of the substrate, have electrical conductivity, are fed with electric power from a feeding point, the first portion extending from the feeding point in a first direction, the second portion extending from the feeding point in a second direction; and an emitting element which has electrical conductivity, is formed in a loop shape in such a manner that the emitting element surrounds the substrate along a surface perpendicular to the first surface, and includes a first end provided so as to electromagnetically couple to the first portion on the first surface and a second end provided so as to electromagnetically couple to the second portion on the first surface, a gap being disposed between the first end and the second end.

11 Claims, 14 Drawing Sheets





US010476167B2

(12) **United States Patent**
Ayala Vazquez et al.

(10) **Patent No.:** **US 10,476,167 B2**
(45) **Date of Patent:** **Nov. 12, 2019**

(54) **ADJUSTABLE MULTIPLE-INPUT AND MULTIPLE-OUTPUT ANTENNA STRUCTURES**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

1,576,433 A * 3/1926 Bragg B60K 25/04
123/198 R

(72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Nanbo Jin**, Milpitas, CA (US); **Hongfei Hu**, Santa Clara, CA (US); **Han Wang**, Cupertino, CA (US); **Erdinc Irci**, Sunnyvale, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Matthew A. Mow**, Los Altos, CA (US); **Ming-Ju Tsai**, Sunnyvale, CA (US); **Liang Han**, Sunnyvale, CA (US); **Georgios Atmatzakis**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

8,350,761 B2 1/2013 Hill et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2013535117 A 9/2013

OTHER PUBLICATIONS

Enrique Ayala Vazquez et al., U.S. Appl. No. 15/657,001, filed Jul. 21, 2017.

(Continued)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

Primary Examiner — Graham P Smith

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 239 days.

Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons

(21) Appl. No.: **15/655,660**

(22) Filed: **Jul. 20, 2017**

(65) **Prior Publication Data**

US 2019/0027833 A1 Jan. 24, 2019

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 5/35 (2015.01)
(Continued)

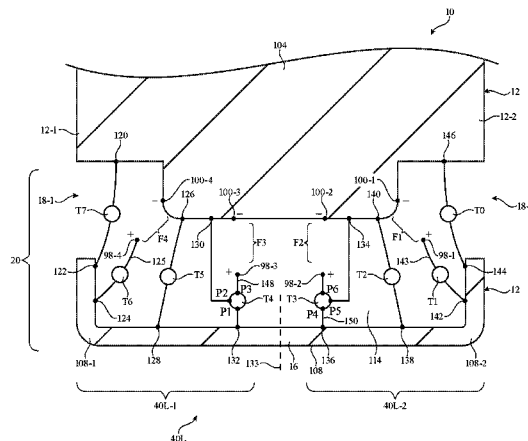
(52) **U.S. Cl.**
CPC **H01Q 21/0006** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 5/35; H01Q 1/243; H01Q 21/0006;
H01Q 5/342; H01Q 9/145; H01Q 9/42;
H01Q 21/28; H01Q 1/48
See application file for complete search history.

(57) **ABSTRACT**

An electronic device may include antennas, a ground, and a housing. First and second gaps in the housing may define a segment that forms a resonating element for a first antenna. First, second, third, and fourth antenna feeds may be coupled between the segment and ground. Control circuitry may control adjustable components to place the device in first, second, third, or fourth modes. In the first and second modes, the first and fourth feeds convey signals at the same frequency using a multiple-input and multiple-output scheme while the second and third feeds are inactive. In the third mode, the second feed is active and the first, third, and fourth feeds are inactive. In the fourth mode, the third feed is active and the first, second, and fourth antenna feeds are inactive. Isolating return paths may be coupled between the segment and ground in the first and second modes.

20 Claims, 13 Drawing Sheets





US010477713B2

(12) **United States Patent**
Allore et al.

(10) **Patent No.:** **US 10,477,713 B2**
(45) **Date of Patent:** **Nov. 12, 2019**

(54) **SINGLE-PIECE METAL HOUSING WITH INTEGRAL ANTENNAS**

(71) Applicant: **Motorola Mobility LLC**, Chicago, IL (US)

(72) Inventors: **Joseph L Allore**, Mundelein, IL (US); **Mohammed R Abdul-Gaffoor**, Palatine, IL (US); **Michael J Lombardi**, Lake Zurich, IL (US)

(73) Assignee: **Motorola Mobility LLC**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1054 days.

(21) Appl. No.: **14/613,406**

(22) Filed: **Feb. 4, 2015**

(65) **Prior Publication Data**

US 2016/0226130 A1 Aug. 4, 2016

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H05K 5/02 (2006.01)

(52) **U.S. Cl.**
CPC **H05K 5/0247** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 9/0421; H01Q 1/42; H01Q 1/12
USPC 343/702, 872, 878, 866, 879
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0257283 A1* 12/2004 Asano H01Q 1/243 343/702
2005/0012674 A1 1/2005 Takei

2008/0106412 A1 5/2008 Sakama et al.
2009/0102724 A1 4/2009 Tsutsumi
2011/0287715 A1 11/2011 Matsuura et al.
2012/0009983 A1 1/2012 Mow et al.
2012/0157175 A1 6/2012 Golko et al.
2012/0229347 A1* 9/2012 Jin H01Q 1/243 343/702

2013/0082884 A1 4/2013 Gummalla
(Continued)

FOREIGN PATENT DOCUMENTS

CN 203950905 U 11/2014
EP 2996194 A1 3/2016
(Continued)

OTHER PUBLICATIONS

Search Report for related British Application No. GB1601757.6; report dated Jul. 21, 2016.

(Continued)

Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — McKinney Phillips LLC; Phillip Pippenger

(57) **ABSTRACT**

An enhanced portable communication device includes a one-piece metal back plate, configured to reduce device thickness by eliminating the plastic-to-metal joints normally needed to isolate the device antennas and provide rigidity. The one-piece metal back plate includes four integral antennas in an embodiment, forming an antenna pair at each end of the device. An opening and gap used to form each antenna pair may be filled with a nonconductive material such as plastic. In an embodiment, an I/O port is exposed through the nonconductive material in the gap.

9 Claims, 8 Drawing Sheets

